AD-A051 413 CONTROL DATA CORP MELVILLE N Y TRG DIV F/G 13/10
PREDICTION OF FLOW NOISE FOR SPOKANE, (U)
JUN 67 D CHASE
UNCLASSIFIED TRG-023-TM-67-22 NL

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MOST Project 4

(14) TRG-023-TM-67-22

(6) Prediction of Flow Noise for Spokane (U)

(11) 28 Jun 67 (10) D. Chase 6/28/67

(12) 8P.

Reliable prediction of flow noise for Spokane is clearly contingent on identification of noise sources in measurements in previous sea trials. This basic task of the Purvis data analysis has not yet been satisfactorily accomplished~~, as reviewed in a separate memo,~~ except in a frequency range below that of main interest.

In the Purvis II noise measurements on 5"-diameter flush elements located outside the field of apparent bubble flow, the principal contribution to noise at speeds $U_\infty \gtrsim 15$ kt in the frequency range $\omega/2\pi \lesssim 0.75(U_\infty/20 \text{ kt})$ khz is confidently recognized as direct TBL pressure fluctuations. Furthermore, the scaling law for this noise contribution is thought to be established to adequate approximation, as given in Ref. 1. In this same domain, and indeed in a domain more comprehensive though of uncertain extent, the noise spectra are expected to be given similarly for Spokane. In the range of higher frequency, our prediction at present must be more dubious.

Results of noise measurements on large flush elements in several sea trials, referred to free field calibrations, are shown for 0, 10, and 20 kt in Figs. 1, 2, and 3. The curves shown refer to (A) USNUSL element 23 on USS Albacore, ceramic diameter 1.5", boot (3/16" thick) diameter 2.875"; (B) Purvis II element HF-3, diameter 5"; (C) Brownson element H-1, 4.5" (streamwise) x 6.875";

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(D) Brownson element TRG-18, diameter 5".

We consider the comparison among these elements in the frequency range $\omega/2\pi \gtrsim 1.5$ khz. At 10 kt, HF-3, which is typical of elements of the HF and LF Purvis arrays, measures noise averaging of the order of 10 db above the others for 1.5 to 4 khz. Evidence indicates that this excess noise is of machinery and perhaps also water-interface origin and, with care, may be reduced in a Spokane configuration. The USL 23 noise in this instance varies erratically in this frequency range but from 1.5 to 3 khz lies moderately below the levels on the Brownson elements. The USL element is smaller than the others, but we do notbelieve the noise is direct TBL noise, and hence the different area averaging for different element sizes may be of little import. The relatively very low noise measured by TRG-18 near 1 khz and the limited number of runs and variability of spectra from this element suggest that element H-1 is more indicative. In the tenuous light of these results we conjecture the following noise levels for large flush elements on Spokane at 10 kt in the frequency range above that where the TBL prediction is considered applicable:

Frequency (khz)	1.5	2.0	3.0	4.0	8.0	10.0
Noise (db re 1 μbar^2/hz)	-27	-32	-40	-43	-50	-58

At 20 kt, from 1.5 to 4 khz, the noise spectra on USL 23 and HF-3 are nearly equal and those on the Brownson elements average 4 to 6 db lower. At this higher speed, we cannot account with assurance for the difference between the Brownson and Purvis levels.

It appears plausible, if no more, that the noise for the Spokane should be no higher than for the lower set of measurements. With this consideration in mind, we conjecture the following noise levels on large flush elements on Spokane at 20 kt in the upper frequency range:

Frequency (khz)	1.5	2.0	3.0	4.0	8.0	10.0
Noise (db re 1 $\mu bar^2/hz$)	-17	-24	-27	-31	-40	-50

With regard to dependence of noise on element location on Spokane, at speeds $U_{\infty} \gtrsim 10$ kt such that proximity to machinery spaces are expected to be of no great relevance, it is predicted on the basis of the Purvis noise measurements that all elements (provided they are removed from any evidently bubble-infested region) will be subject to substantially the same noise independently of position, and, in particular, of distance aft. Again, so long as the dominant source of high-frequency noise in previous sea trials remains uncertain, a degree of uncertainty must be attached to this prediction.

In the range of lower frequency, roughly where $\omega/2\pi \lesssim 1(U_{\infty}/20$ kt) khz, we expect that the noise spectra on flush elements on Spokane will be given by the levels and scaling inferred for direct TBL noise. If the dominant source of noise on large flush elements in the higher-frequency range measured in the previous sea trials should subsequently be discovered and should prove to be of such origin as to be absent or avoidable in Spokane, it is conceivable that the inferred TBL noise spectra will apply in Spokane up to higher frequency. On the basis mainly of the Purvis measurements on 5"-diameter elements, together

with comparisons and interpretation (see Ref. 1), we predict explicitly that for $\omega R_o/U_\infty \gtrsim 10$ up to some value $\gtrsim 30$, where R_o is the effective element radius, the direct TBL noise, $P(\omega/2\pi)$, will be given approximately by

$$(1) \quad 10 \log \left[P(\omega/2\pi)/\rho^2 R_o U_\infty^3 \right] = -32 - 50 \log(\omega R_o/U_\infty).$$

Predictions based on (1) must be qualified as follows. Eq. (1) yields dependence of $P(\omega/2\pi)$ on R_o as R_o^{-4}, whereas, even if high-wavenumbers predominate, we cannot suppose that $P(\omega/2\pi)$ decreases more rapidly than as R_o^{-3}, i.e., if the right member were exact and depended only on $\omega R_o/U_\infty$, the coefficient given as 50 would be expected to be ≤ 40. This discrepancy is attributed to some small dependence of the measured $P(\omega/2\pi)$ on the additional dimensionless variable $\omega\nu/v_*^2$ or possibly on $\omega h/v_*$, where h denotes an effective roughness height for the flow-bounding surface, a dependence not included in estimate (1). The dependence of TBL noise on ω and U_∞, however, is thought to be given adequately by (1) as it stands within the range specified.

Reference

1. Purvis II Second Data Analysis Report, TRG-023-TM-67-19, May, 1967 (CONFIDENTIAL).

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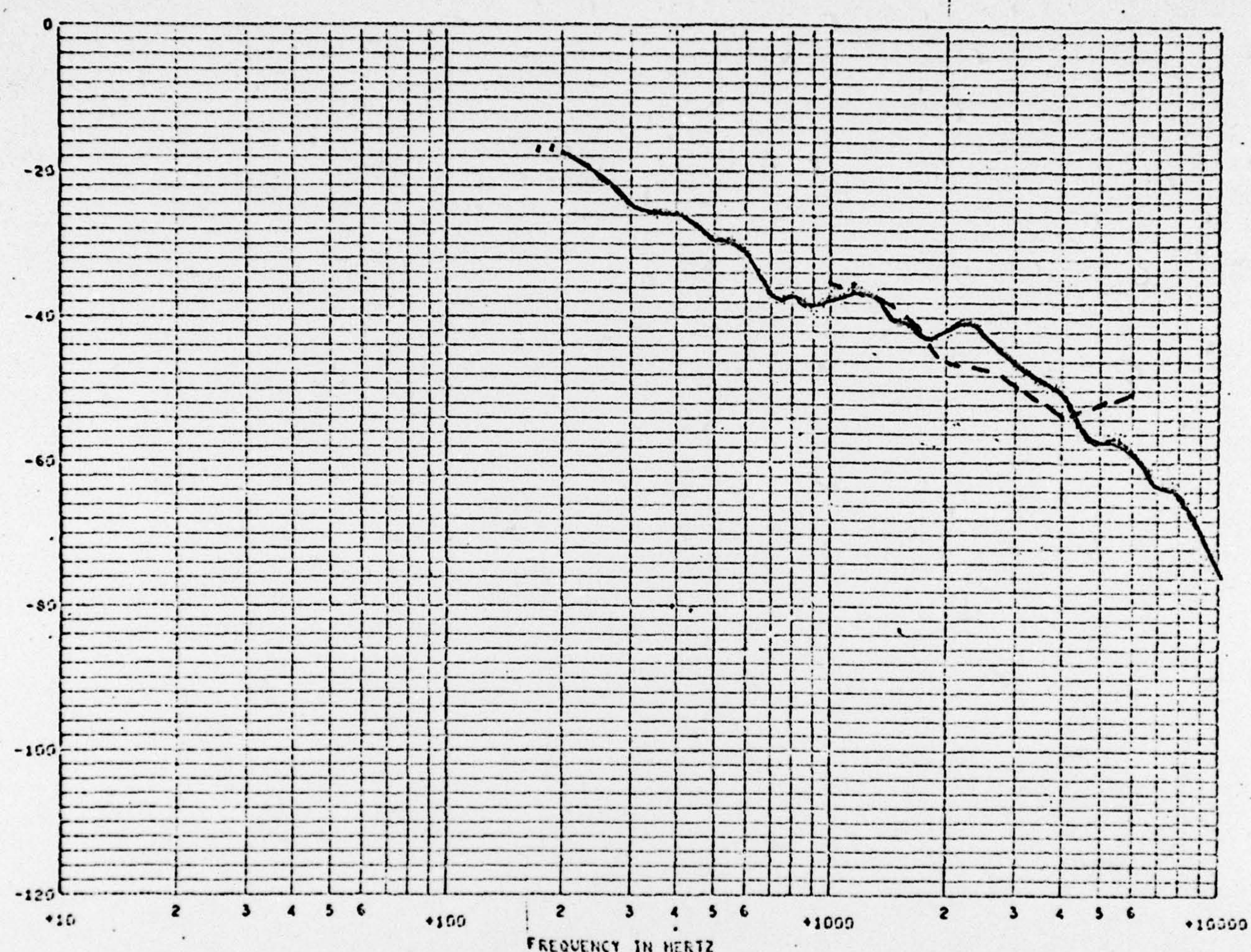
SPEED: 0 KTS



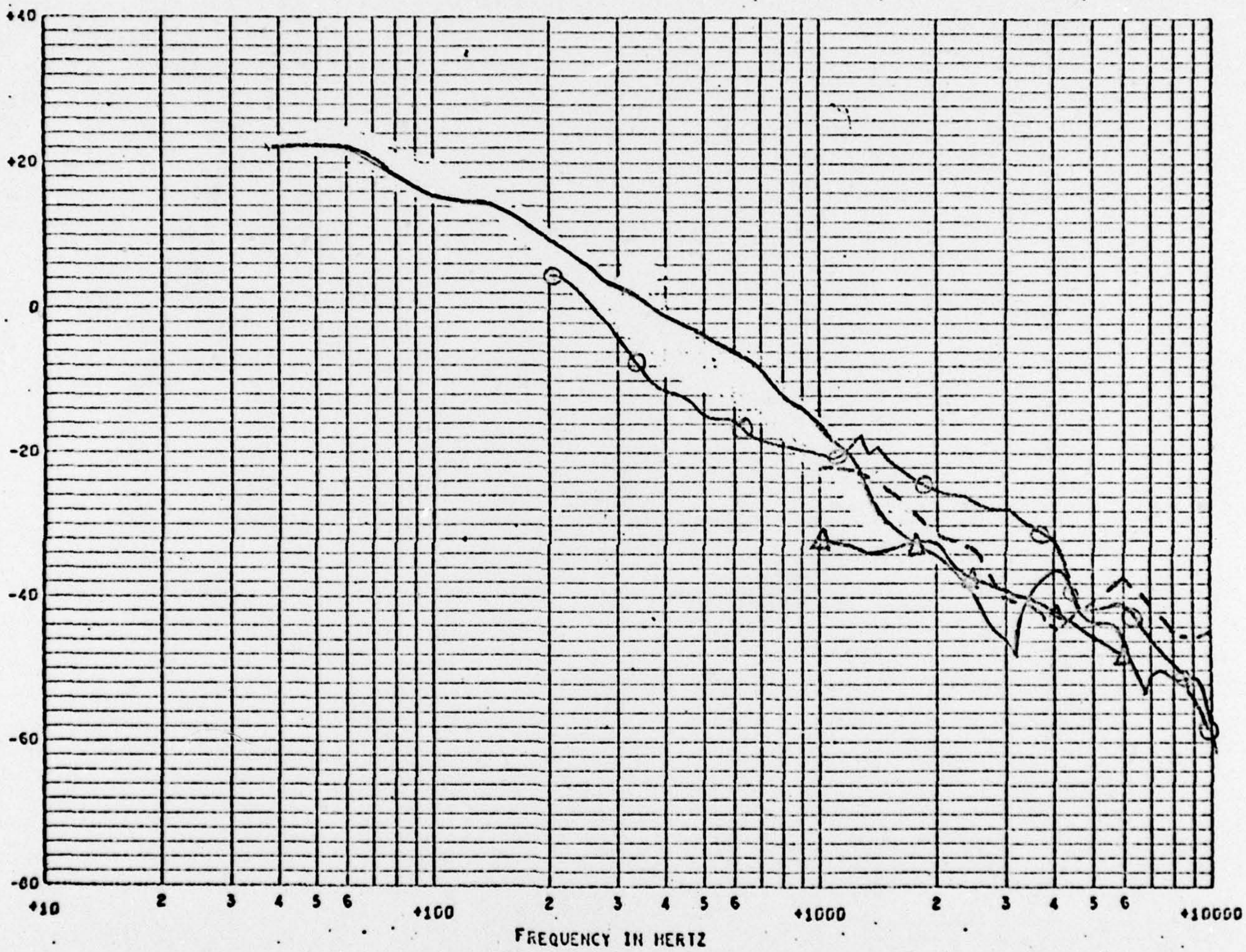
SPECTRUM DB REF 1 MICROBAR SQUARED TIMES SEC GXX LOW BAND CF56 - 1B - HIGH BAND CF56 - 3B
RUN 336 START TIME 14*02*10.0 SPEED 00 HEADING 000
TYPE SER NO FT FROM BOW
TRG HF-3 026 09.75

A: HF-3, Run 336, ————

B: H-1 (BROWNSON). – – – –

Fig. 1

SPEED: 10 KTS



SPECTRUM DB REF 1 MICROBAR SQUARED TIMES SEC GXX LOW BAND CP77 - 24A HI BAND CP77 - 18A
RUN 6C3 START TIME 00*57*14.0 SPEED DEL 5 SMOOTH FN 3L

TYPE	SER NO	COMMENTS
HYDRO	23	1.500 DIA 034 10.00 00800

A; USL#23, Run 6C3-6C0

B: HF-3, Run 338,

C; H-1 (BROWNSON),

D: TRG#18,

 Fig. 2

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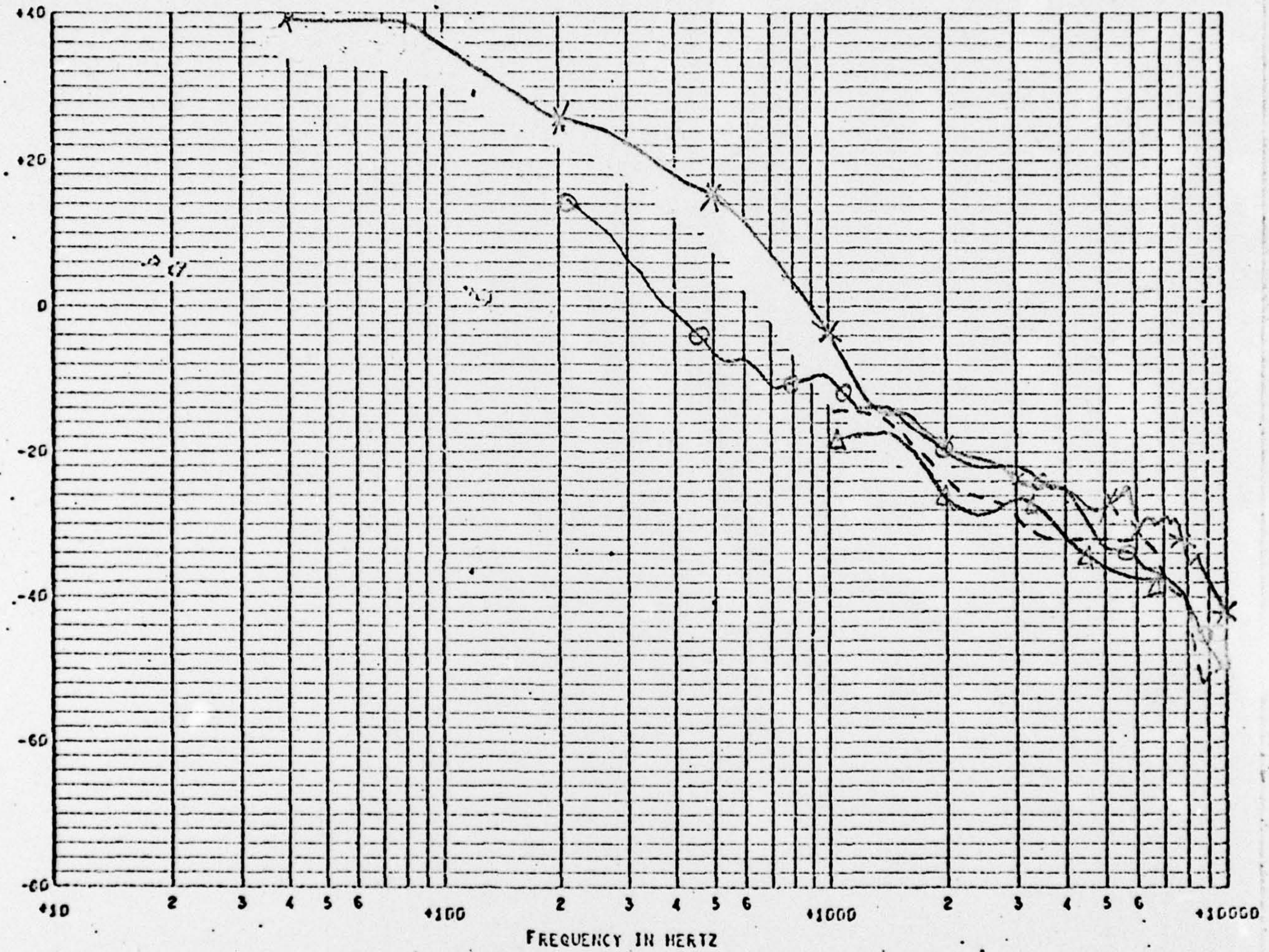
SPEED: 20 KTS



SPECTRUM DB REF 1 MICROBAR SQUARED TIMES SEC GXX LOW BAND CF77 - 6A HI BAND CF77 - 12A

RUN 5C3 START TIME 00423440.0 SPEED DEL 3 SMOOTH FN 3L

TYPE	SER NO	COMMENTS
HYDRO	23	1.500 DIA 034 10.00 00800

A: USL#23, Run 5C3-5C9, —×—×—

B: HF-3, Run 3404, —o—o—

C: H-1 (BROWNSON) - - - - -

D: TRG#18 —△—△—

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